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Office of Secretary

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

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June 2, 1997

Mr. William F. Caton
Secretary
Federal Communications Commission
1919 M Street, N.W.
Room 222
Washington, D.C. 20554

Re: IB Docket No. 96-220, Ex Parte Presentation

Dear Mr. Caton:

The purpose of this filing is to address, within the above-captioned docket, the accommodation of an additional CDMA system in the non-voice, non-geostationary mobile satellite-service. Within this proceeding, E-SAT, Inc. has expended considerable efforts to demonstrate how an additional CDMA system can be accommodated. The proposed method of operation which E-SAT could utilize demonstrates that an additional CDMA system can be operated in portions of the 137-138 MHz and 148-149 MHz band without causing unacceptable interference to existing NVNG MSS licensees. This method was extensively discussed in two separate ex parte filings, both dated April 10, 1997.

In addition, this letter responds to the filing of Leo One USA of May 12, 1997. In its letter, Leo One states its view that E-SAT's operation co-frequency in the Earth-to-space direction with an FDMA system would impair the operation of DCAAS for the FDMA system (See Attachment A).

For the convenience of the Commission, the technical material contained in the April 10, 1997 filings also is attached to this current filing (Attachments B and C). E-SAT will file an amendment to its original application incorporating these changes as soon as the Commission issues an NPRM specifying the requirements with which amended applications must comply. E-SAT has not yet filed an amendment because the Commission has not yet indicated what requirements such comforming applications must meet.

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List A B C D E

In demonstrating compatibility of an additional CDMA system with existing licensees, E-SAT has received extraordinary cooperation from GE Starsys in developing a frequency use plan which would accommodate an additional CDMA system operating co-frequency with the current NVNG MSS licensees. In contrast, E-SAT has not received a similar level of cooperation from ORBCOMM.

As E-SAT presented in its filing of April 10, 1997, the power-flux density of an additional NVNG MSS CDMA system, such as E-SAT, can operate with a PFD of -158 dBW/m^2/4kHz (space-to-Earth) and -161 dBW/m^2/4kHz (Earth-to-space). With these characteristics employed by an additional NVNG MSS system, ORBCOMM would not be able to detect the CDMA signal based on the parameters for which its system is licensed.

However, as the Commission is aware, ORBCOMM claims that its DCAAS system, the technical details of which have not been finalized or included in ORBCOMM's authorization, would receive unacceptable interference from a CDMA system operating co-frequency in the Earth-to-space direction. ORBCOMM attempts to rely upon documentation in the ITU Radiocommunications Sector as a basis for its assertion of an inability to operate co-frequency with a CDMA system using the extremely low power-flux density of -161 dBW/m^2/4kHz. While such documentation exists, the technical basis for ORBCOMM's position has not been reviewed by the Commission nor has the Commission approved the technical parameters of ORBCOMM's proposed DCAAS operations. Moreover, as the Commission is aware, ITU-R actions are not binding on administrations and generally are not used for resolving coordinations within a single administration.

E-SAT believes that the Commission, in determining whether a CDMA system can operate co-frequency with ORBCOMM, should consider the lack of cooperation shown by ORBCOMM in this matter, in contrast to the cooperation demonstrated by GE Starsys. The Commission has always emphasized the importance of its licensees cooperating fully in matters of coordination, particularly when the Commission's policy of promoting competition in the marketplace is at stake.

Nevertheless, in order to address fully ORBCOMM's stated requirements for protection in the uplink direction, attached to this letter (Attachment A) is a further technical statement (in addition to the alternatives submitted on April 10, 1997) which describes how E-SAT can operate co-frequency with ORBCOMM, or any other FDMA system employing DCAAS, in the event the parameters of the ORBCOMM DCAAS system are finalized and approved by the Commission. An additional CDMA system, such as E-SAT, can be licensed with such technical and operating parameters and subject to the coordination that would be required of all NVNG MSS licensees. Once E-SAT receives final operational authority, only minor changes are needed to coordinate with ORBCOMM, similar to those that any other satellite interest (including ORBCOMM) must undergo.

The comments made by Leo One may be appropriate objections for an existing licensee to make to a pending applicant, but they are not appropriate objections for one pending applicant to make to another applicant. E-SAT enjoys equal status vis-a-vis Leo One in the application process. E-SAT will work with Leo One and other applicants within the licensing process to ensure that both systems can operate without harmful interference. Rather than engaging in speculative and uninformed criticisms of other systems, E-SAT believes it would be significantly more productive to arrive at a mutually agreeable settlement based on technical coordination between companies. Moreover, the actions discussed in Attachment A, which could be undertaken by E-SAT to protect ORBCOMM's DCAAS operations should enable E-SAT to share spectrum with other FDMA systems in the Earth-to-space direction.

If you have any questions concerning this filing, please contact the undersigned or Fred Thompson of E-SAT, Inc. at (415) 380-8055.

Sincerely yours,

Leslie A. Taylor
Guy T. Christiansen

Attachments A - new technical discussion
Attachments B and C - technical attachments to April 10, 1997 filings

cc: Peter Cowhey, Chief, International Bureau
Thomas Tycz, International Bureau
Harold Ng, International Bureau
Julie Garcia, International Bureau
Cassandra Thomas, International Bureau
Ruth Milkman, International Bureau
Bill Hatch, NTIA
David McGinnis, NOAA

Attachment A

E-SAT Sharing with FDMA Systems Using DCAAS

E-SAT, Inc. has considered further potential revisions to its system design and operational parameters in order to eliminate any potential impact on DCAAS subsystems, should the Commission determine that such protection is required. Several E-SAT actions would be undertaken, including an increase in E-SAT's raw data rate, and a decrease in the number of simultaneous users.

To eliminate the impact of the E-SAT system on DCAAS subsystem operations in the 148.905 - 149.9 MHz, E-SAT would increase its raw data rate to 2.6 kbps. Since the channelizing is 2.5kHz bands for the DCAAS sampling, this shifts E-SAT's spectrum of information higher so that it is outside the band pass of the DCAAS subsystem. The effect seen by the DCAAS subsystem will be absolutely minimized and any effect seen shall be predominantly due to non-linearities in the receive end of the DCAAS subsystem. Additionally, this reduces the average E-SAT user uplink message duration from 400 milliseconds to approximately 154 milliseconds. This will reduce the uplink message cycle from approximately 80% to just over 30%.

However, increasing the raw data rate has a negative impact on E-SAT's link margin. In order to compensate for this impact, and still not negatively impact the DCAAS system, it would be necessary to modify several aspects of E-SAT's uplink system. The most significant change is the increase in the allowable bit error rate. This had been originally set at one error in 107. This has now been changed to allow one bit error in 105. Additionally, E-SAT has added an outer Reed-Solomon code to the inner Viterbi code to increase the code gain. The end result is to maintain a reasonable link margin of 2.01 dB for E-SAT.

In addition to the modifications above, E-SAT is willing to reduce the number of concurrent users to lower the noise floor for an FCC approved DCAAS system. The actual number of concurrent users should be determined only after a full analysis to determine the actual level of the noise floor for a given number of concurrent users. Although the theoreticial noise floor increase due to E-SAT would be somewhere between 0 and 19.1dB, the actual noise floor will be near 9 dB. In theory, one could simulate either extreme of this range in a lab environment but in real world applications the likelihood of either extreme is near zero. This probability has been described in many text books for decades (see, Panter, Modulation Noise and Spectral Analysis). Therefore, E-SAT is willing to modify its system to coordinate with DCAAS systems that are designed and licensed in accordance with FCC requirements.

Leo One makes several claims regarding the sufficiency of E-SAT's sharing analysis that evidences some misunderstanding of CDMA technology on the part of Leo One.

With regard to frequency diversity and the number of concurrent users, Leo One claims that E-SAT's analysis is flawed because E-SAT failed to sum the signal power of individual transmitters. Because CDMA signals do not have a carrier as do FDMA or TDMA signals, but spread over a broad bandwidth, summing signals does not give an accurate represenation of the real world operation of CDMA systems. In order for the total power from a group of CDMA transmission to be equal to the sum of their individual signal powers, all terminals in a given area would have to transmit exactly the same message, at exactly the same time and at the exact same frequency (with no Doppler shift from the satellite). It is virtually impossible for such an event to happen, and thus should not be used as the basis for an interference analysis. The uplink power E-SAT uses in its analysis provides a reasonable estimate of the aggregate transmitter power. Finally, while Leo One addresses the interference that might be caused by E-SAT to its system, it fails to put this potential consideration into the appropriate context. Even if E-SAT's signal is perceptable to FDMA systems (which is extremely unlikely), the amount E-SAT's signal will boost the noise floor will be minuscule when compared to the effect Canadian paging operations will have on DCAAS.

Appendix A to this Attachment provides a detailed link budget for E-SAT's proposed operation, utilizing this scenario for protection of FDMA systems employing DCAAS.

Appendix A: Uplink Communication Budget

Center Frequency	149.225	Mhz		
Bandwidth	1.450	Mhz		
Transmitting RF Power	3.00	Watts	4.77	dBW
Transmitting Line Loss	0.77	dB	(0.77)	dB
Transmitting Antenna Gain	(3.00)	dBi	(3.00)	dB
EIRP per User			1.00	dBW
EIRP per User per 4 kHz			(24.59)	dBW
Free Space Path Loss	135.60	dB	(135.60)	dB
Atmospheric Loss	0.20	dB	(0.20)	dB
Rain Loss	-	dB	-	dB
Polarization Loss	0.50	dB	(0.50)	dB
Antenna Pointing Loss	0.05	dB	(0.05)	dB
Receiver Power Flux Density per User			(135.35)	dBW
Receiver PFD per User per 4kHz			(160.94)	dBW
Receiver Line Loss	0.25	dB	(0.25)	dB
Spacecraft Receiving Antenna Gain	6.00	dBi	6.00	dBi
Received Carrier Power per User			(129.60)	dBW
Boltsman Constant	(228.60)	dBW	228.60	dBW
Thermal Noise Density (No)	(203.70)	dBWHz	203.70	dBWHz
C/No per User			74.10	dBHz
Data Rate	2,600.00	bps	(34.15)	
Mechanization Loss	1.00	dB	(1.00)	
Eb per User			(164.75)	dBHz
Eb/No per User			38.95	dB
Number of Simultaneous Users	81.00			
Spreading Bandwidth	1.45	MHz		
Interference (Io)			(168.65)	dBWHz
Eb / (No+Io)			3.90	dB
Coding Gain (Reed-Solomon & Viterbi)			7.70	dB
Required Eb / (No+Io)			9.59	dB
Margin			2.01	dB

Appendix A (cont'd): Downlink Communication Budget

Center Frequency	137.500	MHz		
Bandwidth	1.000	MHz		
Transmitting RF Power	0.50	Watts	(3.01)	dBW
Transmitting Line Loss	0.50	dB	(0.50)	dB
Transmitting Antenna Gain	6.00	dBi	6.00	dB
EIRP per User			2.49	dBW
EIRP per User per 4 kHz			(21.49)	dBW
Free Space Path Loss	136.00	dB	(136.00)	dB
Atmospheric Loss	0.20	dB	(0.20)	dB
Rain Loss	-	dB	-	dB
Polarization Loss	0.50	dB	(0.50)	dB
Antenna Pointing Loss	0.30	dB	(0.30)	dB
Receiver Power Flux Density per User			(134.51)	dBW
Receiver PFD per User per 4kHz			(158.49)	dBW
Receiver Line Loss	0.77	dB	(0.77)	dB
Spacecraft Receiving Antenna Gain	(3.00)	dBi	(3.00)	dBi
Received Carrier Power per User			(137.51)	dBW
Boltsman Constant	(228.60)	dBW	228.60	dBW
Thermal Noise Density (No)	(200.20)	dBWHz	200.20	dBWHz
C/No per User			62.69	dBHz
Data Rate	1,000.00	bps	(30.00)	
Mechanization Loss	1.00	dB	(1.00)	
Eb per User			(168.51)	dBHz
Eb/No per User			31.69	dB
Interference (Io)			(182.00)	dBWHz
Eb / (No+Io)			13.49	dB
Coding Gain (Reed-Solomon & Viterbi)			5.70	dB
Required Eb / (No+Io)			11.30	dB
Margin			7.89	dB

Attachment B

E-SAT Analysis Of DCAAS Users Band Sharing Opinions

Orbcomm is proposing a DCAAS system which has not been finalized, tested and verified through actual monitoring. There are five potential solutions to accommodate Orbcomm's proposed "requirements". These items are the following:

1. Spatial Diversity:
E-SAT can optimize the spatial diversity but with the E-SAT satellites in a single plane it is already somewhat optimized the theoretical upper limit of E-SAT uplink time from CONUS is less than 30% of each day. Going to two planes does not increase the system throughput and only increases the percentage of time that there will be a user uplinking from CONUS.

2. Frequency Diversity:
E-SAT is currently proposing to put its center frequency at 149.175 with a bandwidth of only 1.45 MHz. Under this band plan there will always be at least 19.5% of Orbcomm's band for which E-SAT's power level is below Orbcomm's stated cut off with DCAAS even with 81 concurrent users.

3. Transmit Power:
E-SAT's current system uses 1.00 dBW to uplink from each user set. If E-SAT utilized more encoding of the data stream and lowered the allowable bit error rate, then the power could probably be reduced by 3 dB (or more). This would directly translate into a decrease of 3 dB (or more) of received power at Orbcomm's satellite.

4. Concurrent Users:
The currently proposed maximum number of concurrent users is 81 on the E-SAT system. This number could be reduced as allowable by E-SAT's business base. Obviously, E-SAT will not need to utilize all 81 concurrent users when it launches its first constellation. E-SAT's business base will grow into some sizable fraction of this set of 81 concurrent users. If E-SAT were to reduce the maximum number of concurrent users to 40 there would be a reduction of 1.53 dB at Orbcomm's satellite. If E-SAT is using 20 concurrent users there is a reduction of 3.03 dB at Orbcomm's satellite.

5. Polarization Diversity:
E-SAT could utilize a polarization on its uplink that is the opposite sense to that of the receiving system on the Orbcommm satellite. In a perfect system (both on E-SAT's transmission and Orbcomm's reception) the isolation would be infinite. In a real world application this would realistically be 20 dB. It is safely 17dB or more. This means that the allowable PFD would be as high as -142 dBW and no lower that -145 dBW.

Analysis:
Most of the solutions will reduce the dB level at the DCAAS monitor. Depending on the final specifications of the monitor, the best solution will be selected. Based on Orbcomm's proposed specifications, putting a circularly polarized antenna on the user set

that transmits up in the opposite sense that Orbcomm receives provides the most reduction to interference. Since none of Starsys' calculation have been based upon any type of polarization diversity with E-SAT, there would be no impact on the Starsys system other than what they have already calculated and shown to E-SAT and others.

If Orbcomm's DCAAS rejects channels as currently proposed, E-SAT can develop a system that will be compatible with Orbcomm's DCAAS. Below is a synopsis of each system.

Orbcomm's stated DCAAS specifications:

Sensing Channel Bandwidth:	2.5 kHz
Sensing Channel Sensitivity level:	-167 dBW
Rejection "Channel Bandwidth":	7.5 kHz
Rejection "Channel" sensitivity:	-162 dBW
Rejection "Channel" rejection level:	-162 dBW
Satellite antenna full width:	104 degrees
Satellite antenna gain on center:	-2 dBi
Satellite antenna gain on beam edge:	+3 dBi
Satellite antenna receive polarization	Right Circular

As stated above, if Orbcomm's proposed DCAAS requirements are to be those specifications then E-SAT would design a system with the following specifications to be completely compatible with Orbcomm's DCAAS.

E-SAT's compatible user uplink system:

Center Frequency	149.175	MHz		
Bandwidth	1.450	MHz		
Transmitting RF Power	3.00	Watts	4.77	dBW
Transmitter Line Loss	0.77	dB	(0.77)	dB
Transmitting Antenna Gain	(3.00)	dBi	(3.00)	dB
EIRP per User			1.00	dBW
EIRP per User per 4 kHz			(24.59)	dBW
Free Space Path Loss (nadir to 750 km)	133.67	dB	(133.67)	dB
Atmospheric Loss	0.20	dB	(0.20)	dB
Rain Loss		dB	-	dB
Polarization Diversity	20.00	dB	(20.00)	dB

Antenna Pointing Loss	0.05	dB	(0.05)	dB
Received Power Flux Density per User			(152.92)	dBW
Received PFD per User per 4kHz			(178.51)	dBW
Received PFD per User per 7.5kHz			(175.78)	dBW
Received Power Flux Density for 81 concurrent users			(143.38)	dBW
Received PFD for 81 concurrent users per 4kHz			(168.97)	dBW
Received PFD for 81 concurrent users per 7.5kHz			(166.24)	dBW
Receiver Line Loss	-	dB	-	dB
Spacecraft Receiving Antenna Gain	(2.00)	dBi	(2.00)	dBi
Received Carrier Power per User			(154.92)	dBW
Received PFD per User per 4kHz			(180.51)	dBW
Received PFD per User per 7.5kHz			(177.78)	dBW
Received Power Flux Density for 81 concurrent users			(145.38)	dBW
Received PFD for 81 concurrent users per 4kHz			(170.97)	dBW
Received PFD for 81 concurrent users per 7.5kHz			(168.24)	dBW
Margin below Orbcomm's DCAAS			6.24	dBW
Peak 7.5 kHz band:				
Received PFD for 81 concurrent users per 4kHz			(168.55)	dBW
Received PFD for 81 concurrent users per 7.5kHz			(165.82)	dBW
Maximum margin below Orbcomm's DCAAS			3.82	dBW

E-SAT Spectrum Use Plan

Uplink 148 - 150 MHz Band

E-SAT will use a Direct Sequence Spread Spectrum technique over a 1.4 MHz bandwidth. This band will be from 148.450 - 149.900 MHz.

Downlink 137 - 138 MHz Band

This link will be a Direct Sequence Spread Spectrum technique over a 1 MHz bandwidth. This band will be from 137 - 138 MHz.

Interference

1. Narrowband users

E-SAT's power flux density (pfd) in both the space-to-Earth and Earth-to-space direction will be below the receive threshold of narrowband users of the band. Because E-SAT will operate with a pfd of -158 dBW/M^2/4kHz (downlink - measured on the ground), and -161 dBW/M^2/4kHz (uplink - measured in space), narrowband users of the band will not be able to detect the E-SAT signal.

2. Spread-spectrum users

E-SAT will use an opposite circular polarization from Starsys and will use different CDMA code strings to allow co-frequency sharing. In the case of the uplink, E-SAT's center frequency (149.175) will be offset from the center frequency of Starsys. E-SAT will pick a code set that is orthogonal to that used by Starsys in both uplink and downlink.

E-SAT will not operate co-frequency with S-80.

Concerns have been raised that E-SAT's use of uplink frequencies (148.905 to 149.900 MHz) may effect the operation of some DCAAS systems utilized by TDMA/FDMA operators. Several operators have proposed a DCAAS design, not yet operable, which E-SAT has addressed with several possible solutions. E-SAT will continue coordination with these operators as they complete their monitor design characteristics.

Attachment C

I. How the E-SAT System Operates

E-SAT proposes to use six satellites for store and forward communications. No real time service is contemplated. E-SAT uses very low power user transceivers to transmit, on a pre-programmed basis, very short messages to the spacecraft. The signals received at the spacecraft are demodulated and then transmitted to the gateway earth stations outside the United States. These gateways will be located at far northern and southern latitudes (Fairbanks, Alaska, Norway and Australia) to provide geographic separation from other users of these bands.

The E-SAT system will transmit a signal to its transceivers alerting them to transmit to the satellite. This downlink signal will be pre-programmed and coordinated with the operations of the other CDMA systems (STARSYS and S-80) so that the downlink transmissions are not made when there is a possibility of interference into the STARSYS or S-80 gateway antennas. Because E-SAT has total flexibility over the schedule of both downlink and uplink transmissions, it can avoid causing unacceptable interference to these systems.

E-SAT's feeder links will be contained in the bandwidth used for service links. It does not need any dedicated feeder links in the Earth-to-space or space-to-Earth direction.

II. Summary of E-SAT technical characteristics relevant to sharing with other NVNG MSS systems (link budgets)

The link budgets for the E-SAT service links are attached to this document.

Because the gateway earth stations will not be located in the United States, and dedicated feeder link assignments are not requested, link budgets are not provided for the links from the satellite to the gateway station and from the gateway stations to the satellite.

III. E-SAT Spectrum Use Plan

<u>Earth-to-space</u>

There are two primary uses for Earth-to-space spectrum which are distinctly different. The implementations are distinctly different. The first use of the Earth-to-space link is for transmitting data from remote users (e.g., electric meters or gas meters) to the E-SAT satellite for storage in the satellite. This link will be a Direct Sequence Spread Spectrum technique over a 1.4 MHz band. This band will be from 148.450 - 149.900 MHz. The received signal is completely demodulated and despread at the satellite. Only the actual data from the meters is stored in the satellite memory.

The other use of Earth-to-space transmissions is for TT&C and scheduling of the remote user reads. As the satellite passes over one of the Gateway Earth Stations, the Earth station transmits satellite control information and any scheduling information that may be required for remote meter reads. This data is stored in the satellite until the appropriate time tagged action is required. E-SAT plans three main Gateway Earth Stations. In order of primary to secondary usage, these will be located in Longyearbyen, Svalbard, Norway; Fairbanks, Alaska, USA; and Perth, Western Australia, Australia. These links shall use a fraction of the same spectrum as the Spread Spectrum use given above. The Feederlink Earth Stations will have high gain antennas. This means the beam to the satellite is highly directional, allowing even greater separation.

Space-to-Earth

As with the Earth-to-space segment, there are two distinct uses for the space-to-Earth spectrum. The first use is for the transmission of a timing and scheduling signal from the spacecraft to the remote users. This link will be a Direct Sequence Spread Spectrum technique over a 1 MHz band. This band will be from 137 - 138 MHz. As is done in the uplink, the received signal of the remote user is completely demodulated and despread within the remote user set. Only the actual time keeping and scheduling data from the satellite is stored in the remote user memory.

The other use of space-to-Earth transmissions is for transmitting satellite status (housekeeping) and orbit data and stored remote user data down to the Gateway Earth Stations. As the satellites pass over the Earth stations they will "dump" all the data that was stored on the previous orbit which was received from the remote users. It is anticipated that by utilizing the Longyearbyen, Svalbard, Norway site and with limited use of the Fairbanks, Alaska, USA site, that sufficient contact can be made with each satellite to allow for download of all the anticipated data. The Perth, Western Australia, Australia site shall be utilized as a backup to the other two sites and will be used only when both primary sites are unavailable.

IV. Explanation of how other NVNG MSS systems using these frequency bands will not experience unacceptable interference from E-SAT transmissions.

A. Feeder links

E-SAT's feeder links will be located in geographically remote areas and will utilize antennas with a relatively small footprint.[1] The attached orbital coverage plots show the footprint of an E-SAT feeder downlink at the middle and the end of its

[1] The beamwidth of the feederlink antenna is 57°. The E-SAT satellite will operate at a constant altitude of 893 kilometers, resulting in a footprint smaller than the state of Alaska.

transmission pass. The spatial separation of the feeder uplinks and downlinks will guarantee that no interference is caused to other users of the bands.

B. Service Links

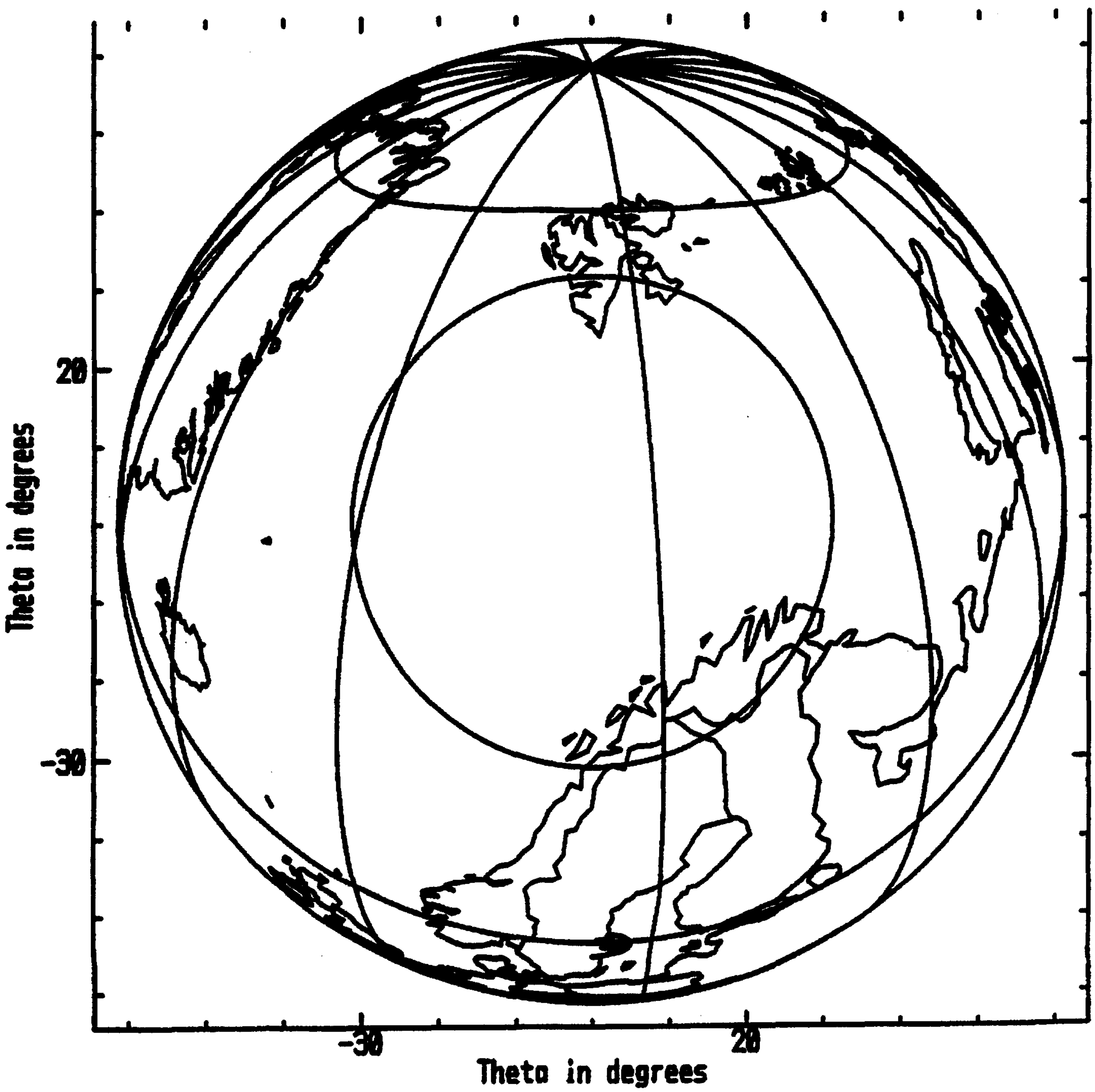
1. Narrowband users

E-SAT's power flux density (pfd) in both the space-to-Earth and Earth-to-space direction will be below the receive threshold of narrowband users of the band. Because E-SAT will operate with a pfd of -158 dBW/M^2/4kHz (downlink - measured on the ground), and -161 dBW/M^2/4kHz (uplink - measured in space), narrowband users of the band will not be able to detect the E-SAT signal.

2. Spread-spectrum users

E-SAT will use an opposite circular polarization from Starsys and will use different CDMA code strings to allow co-frequency sharing. In the case of the uplink, E-SAT's center frequency will be offset from the center frequency of Starsys. E-SAT will pick a code set that is orthogonal to that used by Starsys in both uplink and downlink.

E-SAT will not operate co-frequency with S-80.



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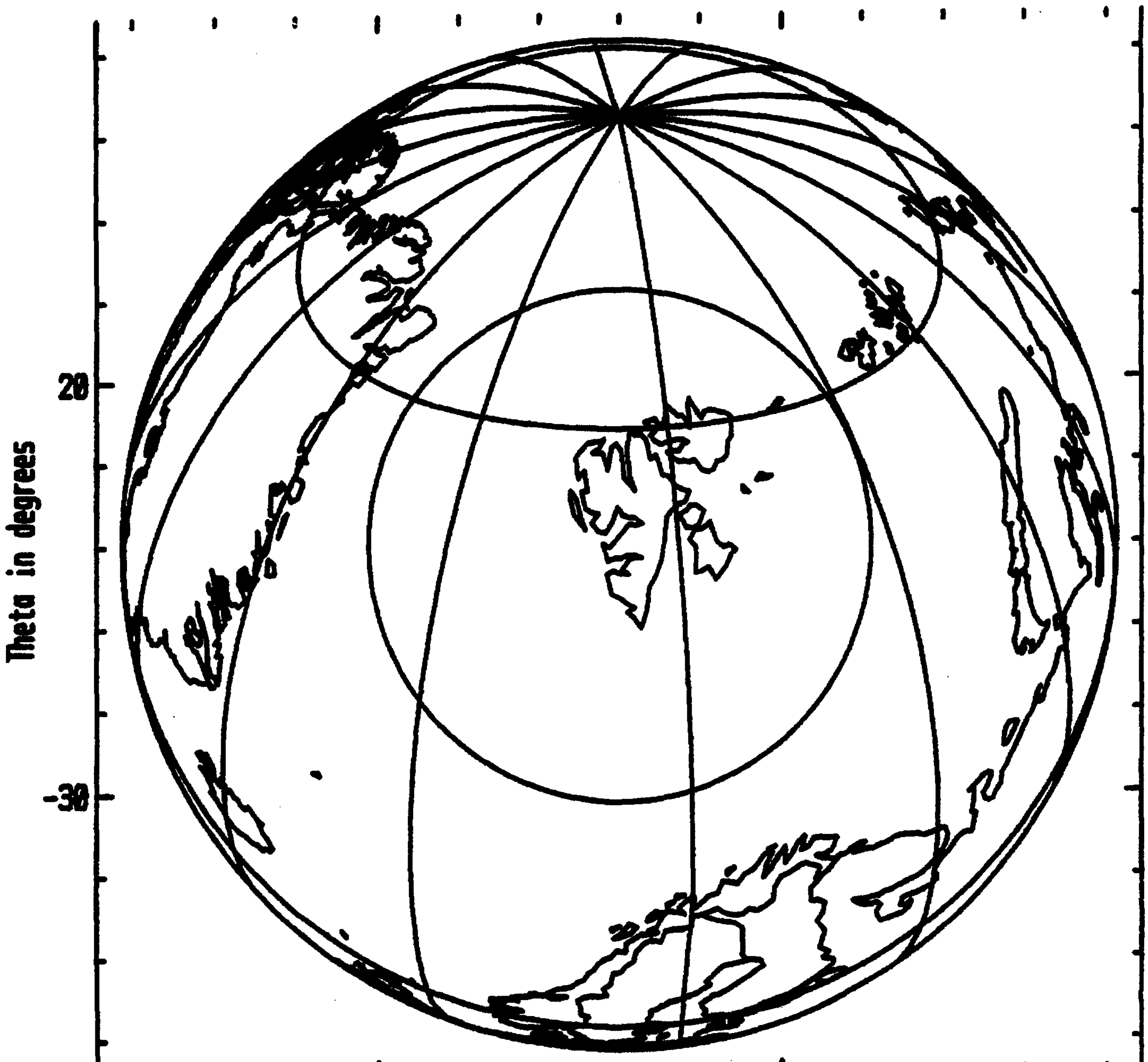

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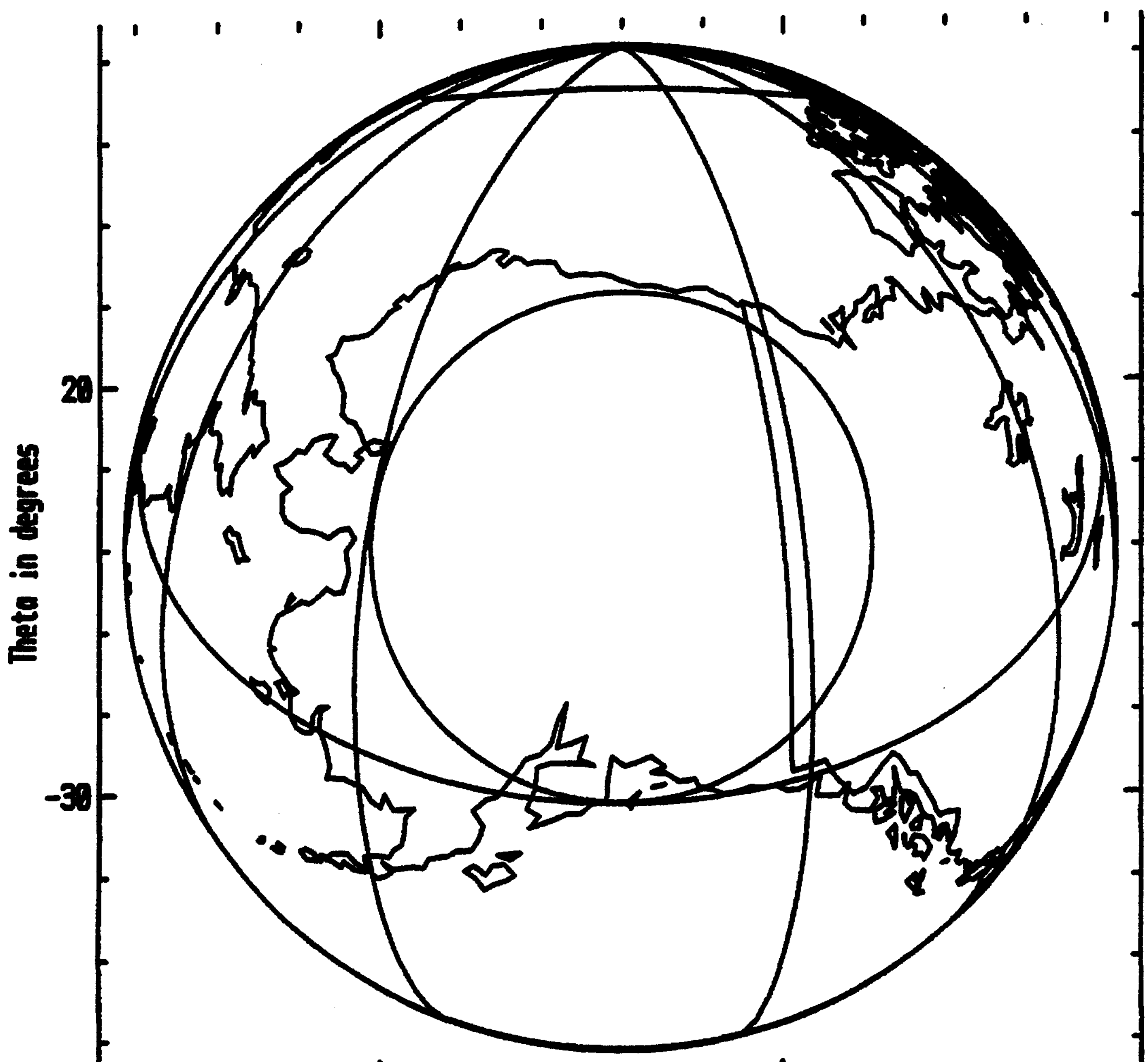
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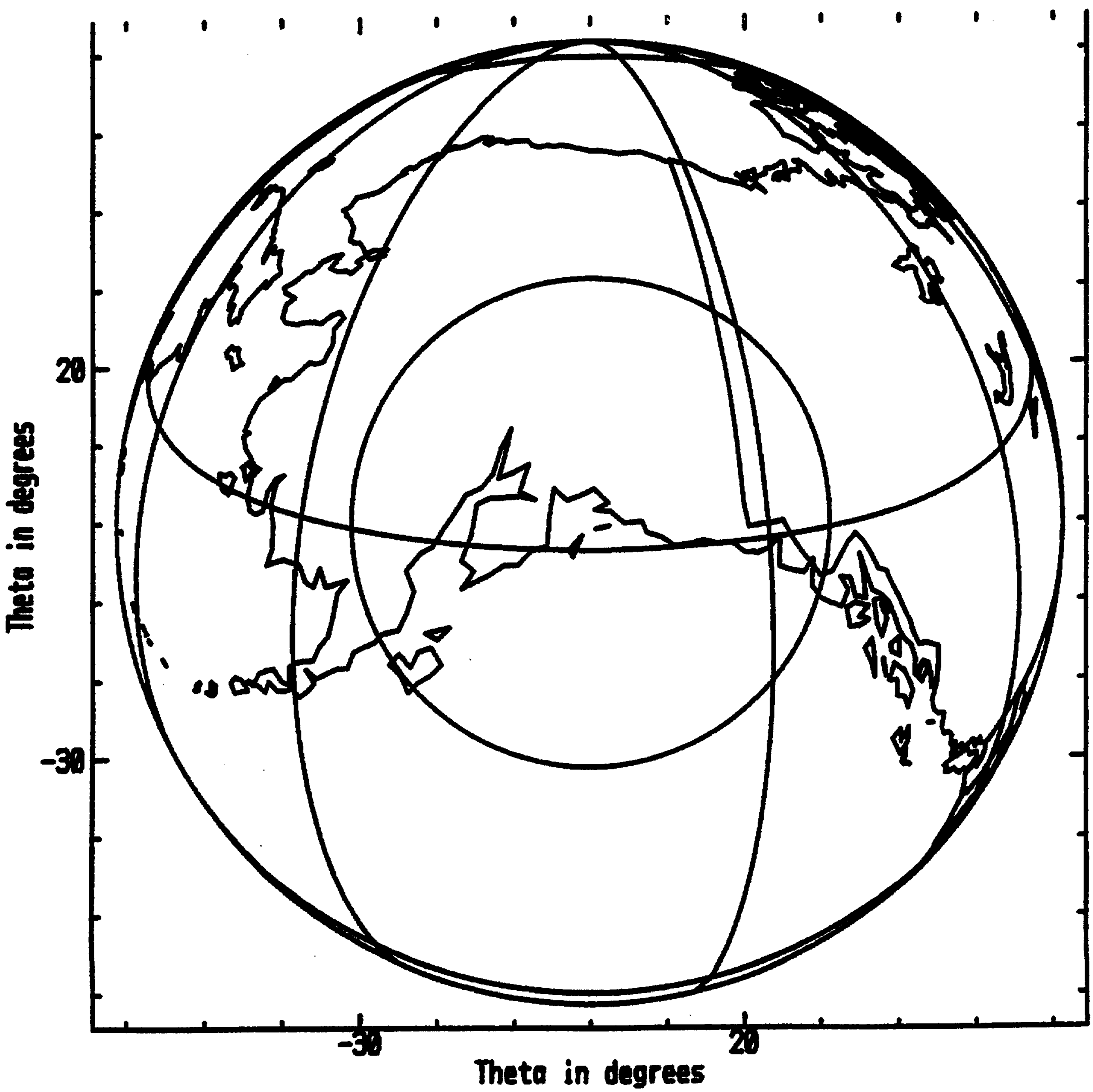
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Sheet3

Center Frequency	149.225	MHz		
Transmitting RF Power	3.00	Watts	4.77	dBW
Transmitter Line Loss	0.77	dB	(0.77)	dB
Transmitting Antenna Gain	(3.00)	dBi	(3.00)	dB
EIRP per User			1.00	dBW
EIRP per User per 4 kHz			(24.59)	dBW
Free Space Path Loss	135.60	dB	(135.60)	dB
Atmospheric Loss	0.20	dB	(0.20)	dB
Rain Loss	-	dB	-	dB
Polarization Loss	0.50	dB	(0.50)	dB
Antenna Pointing Loss	0.05	dB	(0.05)	dB
Received Power Flux Density per User			(135.35)	dBW
Received PFD per User per 4kHz			(160.94)	dBW
Receiver Line Loss	0.25	dB	(0.25)	dB
Spacecraft Receiving Antenna Gain	6.00	dBi	6.00	dBi
Received Carrier Power per User			(129.60)	dBW
Boltsman Constant	(228.60)	dBW	228.60	dBW
Thermal Noise Density (No)	(203.70)	dBWHz	203.70	dBWHz
C/No per User			74.10	dBHz
Data Rate	1,000.00	bps	(30.00)	
Mechanization Loss	1.00	dB	(1.00)	
Eb per User			(160.60)	dBHz
Eb/No per User			43.10	dB
Number of Simultaneous Users	81.00			
Spreading Bandwidth	1.45	MHz		
Interference (Io)			(170.05)	dBWHz
Eb / (No+Io)			9.45	dB
Coding Gain (K7, R1/2)			5.70	dB
Required Eb / (No+Io)			11.30	dB
Margin			3.85	dB

Downlink - E-SAT to Meters

Center Frequency	137.50	MHz		
Transmitting RF Power	0.50	Watt	(3.01)	dBW
Transmitter Line Loss	0.50	dB	(0.50)	dB
Transmitting Antenna Gain	6.00	dBi	6.00	dB
EIRP per User			2.49	dBW
EIRP per User per 4 kHz			(21.49)	dBW
Free Space Path Loss	136.00	dB	(136.00)	dB
Atmospheric Loss	0.20	dB	(0.20)	dB
Rain Loss	-	dB	-	dB
Polarization Loss	0.50	dB	(0.50)	dB
Antenna Pointing Loss	0.30	dB	(0.30)	dB
Received Power Flux Density per User			(134.51)	dBW
Received PFD per User per 4kHz			(158.49)	dBW
Receiver Line Loss	0.77	dB	(0.77)	dB
Meter Receiving Antenna Gain	(3.00)	dBi	(3.00)	dBi
Received Carrier Power per User			(137.51)	dBW
Boltsman Constant	(228.60)	dBW	228.60	dBW
Thermal Noise Density (No)	(200.20)	dBWHz	200.20	dBWHz
C/No per User			62.69	dBHz
Data Rate	1,000.00	bps	(30.00)	
Mechanization Loss	1.00	dB	(1.00)	
Eb per User			(168.51)	dBHz
Eb/No per User			31.69	dB
Interference (Io)			(182.00)	dBWHz
Eb / (No+Io)			13.49	dB
Coding Gain (K7, R1/2)			5.70	dB
Required Eb / (No+Io)			11.30	dB
Margin			7.89	dB